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LABOR MARKET FLUCTUATIONS IN THE SMALL AND IN THE LARGE

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Richard Rogerson, Lodewijk P. Visschers, and Randall Wright
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ABSTRACT

Shimer's calibrated version of the Mortensen-Pissarides model generates unemployment fluctuates much smaller than the data. Hagedorn and Manovskii present an alternative calibration that yields fluctuations consistent with the data, but this has been challenged by Costain and Reiter, who say it generates unrealistically big differences in unemployment from the differences in policy we see across countries. We argue this concern may be unwarranted, because one cannot assume elasticities relevant for small changes work for large changes. Models with fixed factors in market or household production can generate large effects from small changes and reasonable effects from large changes. This is reminiscent of attempts to improve the labor market in the Kydland-Prescott model, especially ones incorporating household production, like Benhabib, Rogerson and Wright.

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1 Introduction

In this paper we comment on the recent debate concerning the aggregate labor market, bringing to bear ideas some of us were thinking about two decades ago, when similar economic issues were being discussed in a different class of models. The recent discussion focuses on the search-based model of the labor market in Mortensen and Pissarides (1994). Shimer (2005) finds in his calibrated version of that model that, when one feeds in realistic cyclical productivity shocks, the implied fluctuations in unemployment are way too low – i.e., much lower than those in the data.¹ Hagedorn and Manovskii (2006) show that for an alternative calibration strategy the same model yields unemployment fluctuations that are very much consistent with the data. This seems like progress. Costain and Reiter (2005, 2007), however, call into question the Hagedorn-Manovskii parameter values for the following reason: they seem to imply that for large changes, like the differences one sees in labor market policies across countries, the model should predicts changes in unemployment that are unrealistically big.

We show that this last conclusion may not be warranted. The simple reason is that one cannot necessarily extrapolate under the assumption that the elasticities relevant for small changes are also relevant for large changes. We show explicitly that for models that take into account fixed factors in either market or household production, we can generate large effects from small productivity changes, just like Hagedorn and Manovskii, and we can also generate more reasonable effects from large changes such as the ones that concern Costain and Reiter. This demonstration is reminiscent of an

¹The literature discussing these findings is too large to go through in detail, but a representative sample might include e.g. Hall (2005), Hall and Milgrom (2007), Farmer and Hollenhorst (2006), Kennan (2006), Mortensen and Nagypal (2007), and Menzio (2005).

older discussion concerning alternative ways to improve the performance of the business cycle model in Kydland and Prescott (1982). Of the many contributions to this discussion, we are particularly fond of ones that incorporated household production into business cycle theory, such as Benhabib, Rogerson and Wright (1991). We find it interesting that home production may be as relevant for the current discussions of Mortensen-Pissarides as it was for the Kydland-Prescott model.

2 The Idea

We begin with some background. In the late 80s and early 90s the Kydland-Prescott (1982) model became the workhorse of business cycle research. There were many reasons for this, including: it is based on firm microeconomic foundations; versions of the model without all the bells and whistles that are sometimes added are tractable and deliver transparent economic effects; and it fits many of the stylized business-cycle facts well. As regards this last point, that model predicts that in response to realistic technology shocks output will fluctuate almost as much as in the data, consumption will fluctuate less than output, as we see in the data, investment will fluctuate more than output, and so on. One aspect in which the baseline model does less well is the performance of labor market variables. For one thing, it predicts employment will fluctuate only about half as much as output, while in the data the variables display very similar fluctuations. For another, the correlation between employment and either wages or productivity is much too strong in the baseline model.

Improving the performance with respect to the labor market was a challenge for business cycle research, and many attempts were made to amend the basic model by adding a variety of ingredients. For example, the orig-

inal Kydland-Prescott (1982) paper introduced preferences for leisure that were not separable over time; Hansen (1985) introduced indivisible labor as in Rogerson (1987); McGrattan (1994) introduced taxes; Christiano and Eichenbaum (1992) introduced government spending shocks; and Benhabib, Rogerson and Wright (1991) introduced household production. While all these extensions proved useful and interesting, home production was especially appealing for several reasons. First, Becker (1988) had previously argued using simple, intuitive, economic reasoning that some notion of home production ought to be incorporated into macro. Second, the data indicate that household production is significant at the aggregate level.² Third, home production fits easily and elegantly into the standard model, in terms of both theory and calibration. Fourth, the model with home production improves the performance of the baseline model along a number of dimensions, including the labor market.³

While the Kydland-Prescott (1982) model is alive and well despite repeated attacks from various flanks, and indeed is still the main paradigm for addressing many issues, the Mortensen-Pissarides (1994) model has arguably become dominant in terms of the labor market. In part this is because it generates unemployment in a simple, natural and interesting way – for one thing, unemployment is a state variable for both the individual and the aggregate economy, which is not true, say, in the Hansen-Rogerson model of

²For example, the representative household spends almost as many hours in nonmarket work as they spend in market work, and investment in nonmarket capital like residential structures and consumer durables actually exceeds investment in market capital like plant and equipment; see Benhabib et al. (1990).

³See Greenwood et al. (1995) for a survey of early home production business cycle models where these points are discussed in much more detail. At the same time, adding home production brings up some new challenges both in terms of theory and measurement, and this framework is the subject of ongoing research. See Greenwood and Hercowitz (1991), Gomme, Kydland and Rupert (2001), McGrattan, Rogerson and Wright (1997), Rupert, Rogerson and Wright (1995, 2000), Parente, Rogerson and Wright (2000), Fisher (2007), Aguiar and Hurst (2005, 2006, 2007), and Gomme et al (2004) for some examples.

indivisible labor. The Mortensen-Pissarides model can be used to address a variety of issues qualitatively and quantitatively, including the effects of various labor market policies.⁴ Although the model in its usual incarnation has some weaknesses compared to the growth model – e.g. it is not so easy to add risk-averse agents and capital – it seems fair to say that it has been successful on a number of fronts.

But there is a problem. Shimer (2005) considers performing an exercise with the Mortensen-Pissarides model similar to what people were doing with Kydland-Prescott many years ago: Calibrate it to match some key observations, hit it with shocks to productivity, and compare the predictions with the data. Since the main (almost the only) interesting variable in the model is the unemployment rate (ok, there is also the vacancy rate, the ratio of these two rates, and so on), let us focus on movement in unemployment over the cycle. It turns out the model performs quite poorly: unemployment barely moves at all in the model, certainly much less than in the data. This observation set off an industry attempting to amend the structure of the basic Mortensen-Pissarides model, with a variety of results, but little in the way of overwhelming success. At the end of the day, a fairly robust finding is that the model as calibrated along the lines of Shimer (2005) delivers a very small effect on unemployment from changes in productivity.

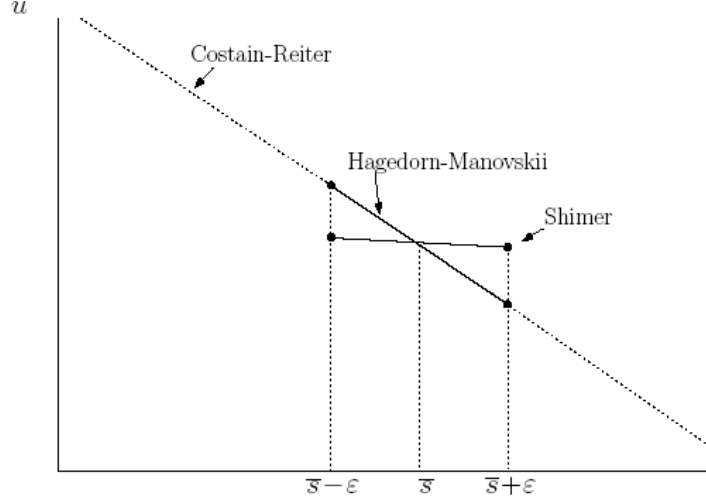
The situation is depicted in Figure 1, where $s = y - z$, y is output per employed worker, and z is some notion of output (or utility, since preferences are linear) per unemployed worker; it is only the difference $y - z$ that matters for the issues at hand. Note that z can include UI payments from the government, the value of leisure, and the value of home production, all measured in the same units as y . For now we interpret changes in s as coming

⁴Ssee Rogerson, Shimer and Wright (2005) for a recent survey with many references.

from shocks to market productivity, y . Actual productivity fluctuations over the cycle are not big, as indicated in the diagram by the values $\bar{s} - \varepsilon$ and $\bar{s} + \varepsilon$. Also, for this discussion, it suffices to imagine comparisons across deterministic steady states rather than fluctuation in a dynamic-stochastic equilibrium, since as is well known the model generates some but not much internal propagation (although unemployment is a state variable, without capital it adjusts quickly). So what we are interested in is really just the magnitude of the change in unemployment u when productivity moves up and down across steady states, as this is a good approximation to what happens over the cycle.

As Figure 1 shows, in a stylized way, with Shimer's calibration u moves only a miniscule amount for these ε changes in s . The reason has been discussed at length in the literature, so we will be brief. The key endogenous choice in the model is an entry decision by firms: whether to post vacancies in an attempt to recruit workers. When s goes up, firms are in principle willing to post more vacancies, which through the search process leads to a fall in u . But when there are more vacancies, the return to search goes up, which workers parlay via the bargaining process into a higher wage w . A higher w eats up much of the gain that would have otherwise accrued to firms, and so in equilibrium entry and hence u end up changing very little. Of course, just how little is a quantitative matter – e.g. the increase in w is stronger when workers have more bargaining power. Hagedorn and Manovskii (2006) show how an alternative calibration strategy, differing from Shimer mainly in the flow value of unemployment z , changes the results dramatically. Given their parameters, Hagedorn and Manovskii find the model fits the facts very well indeed, again represented stylistically in the Figure 1.

There is something to be said for the Hagedorn and Manovskii calibra-



tion. Shimer pinned down z by assuming the only flow utility one gets while unemployed comes from government UI benefits, which has the advantage of being easy to measure but the disadvantage of being totally unrealistic, since it completely ignores the value of leisure and home production. Making z bigger has the following effect. Roughly speaking, when z is higher, a worker has a better outside option, and we can give him low bargaining power without changing the results. That is, the steady state looks similar if we give the worker low bargaining power and high outside option, instead of high bargaining power and a low outside option. But, in response to a change in an exogenous variable, including an increase in productivity, low bargaining power for the worker means w does not react much.⁵ Hence, the effect discussed above is mitigated, so both entry and unemployment respond more to changes in s .

Hagedorn and Manovskii argue that it is not only possible to find parameters that make u in the model move as much as in the data, but that

⁵In the most extreme case where the firm has all the bargaining power, e.g., $w = z$ in any equilibrium and the wage is independent of y .

these parameters emerge from a calibration procedure that is designed to match not volatility in u , per se, but independent observations. This is an important point, although perhaps not everyone is convinced; in any case, it not our main concern. We are interested in asking this: although the model works well at explaining the response of u to changes in y for some parameters, are these parameters reasonable? Asking if they are reasonable is weaker than asking if the parameters emerge in a robust way from a convincing calibration strategy. Well, are they reasonable? The knee-jerk reaction by some in the profession was to say *no* because these parameters imply the unemployed have only slightly lower flow utility than the employed – which of course has to be true when the match surplus $y - z$ is small. We do not find this argument scientific, because flow utilities are not measurable, so we do find it compelling.⁶

A more interesting argument is due to Costain and Reiter (2005, 2007). Suppose the Hagedorn-Manovskii version of the Mortensen-Pissarides model is correct: we accept their parameters and hence can generate reasonably big response in u to realistically small changes in s due to business-cycle productivity fluctuations. Let us try to extrapolate to large changes in z , caused by big differences in productivity, or big differences UI, or whatever, as would be relevant when look across countries instead of over the cycle. Then the model predicts huge changes in u , far bigger than we actually see. Figure 1 show this stylistically, with u getting extremely high when s goes

⁶There is no sense writing down formal models if at the end of the day one is going to assign excessive weight to one's priors about the "voluntary" or "involuntary" nature of unemployment. Moreover, this line of argument leads to a rejection of a much bigger set of models than the Hagedorn-Manovskii version of Mortensen-Pissarides – we would have to dismiss all Walrasian models, where the employed and unemployed get the same flow utility, as well as any indivisible-labor models with efficient risk sharing, where the unemployed actually get a higher flow utility under reasonable conditions (Rogerson and Wright 1988).

much below \bar{s} . Labor market policies like UI do in fact differ a lot across countries, and while unemployment rates do, too, not that much. This seems to be a problem. As Costain and Reiter (2007, p.30) themselves put it,

“Our findings suggest that modeling labor market frictions by calibrating a very small match surplus, as Hagedorn and Manovskii (2006) advocate, is unhelpful because it is inconsistent with robust observations about the effects of labor market policy.”

Although this is certainly serious, we want to take issue with this conclusion. The first issue is that, taken at face value, the argument seems totally defeatist. The endeavor of reconciling the discrepancy between the model and data pointed out by Shimer comes down to generating a big elasticity of u with respect to s . As soon as one succeeds in this endeavor, by whatever means, one is subject to the same dismissal – an elasticity sufficient to yield reasonably big responses of u to small changes in s seems to inescapably lead to unreasonably big responses of u to bigger changes in s . Whether success at the first stage comes from Hagedorn-Manovskii or something else – e.g., an alternative wage setting theory – it seems hard to avoid disaster at the second stage. At least this would seem to be true if not for our other issue with the Costain-Reiter argument. It is based on a fairly naive extrapolation exercise, and we think there are some important nonlinearities that call this into question.

Simple extensions of the baseline model that we describe below indicate that we can get large changes in u from small changes in s without predicting huge changes in u from bigger changes in s . Our conclusion from this is that existing versions of the model, including Hagedorn-Manovskii, may be good local approximations to the world and hence work fine for small changes in s ,

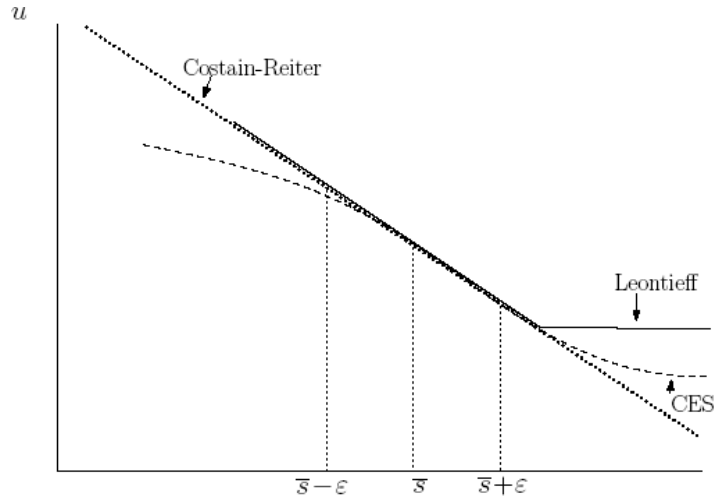
but ought not be taken seriously for very big changes, because there are other factors (literally) that come into play. To show how this works in a simple example, consider an economy with an additional factor necessary for the production of y – it does not matter what it is, and perhaps something like “managerial expertise” may be quite relevant, but for now let’s call it land, ℓ . To make the point in a stark way, we begin with a Leontieff technology: 1 unit of ℓ is needed in any worker-firm match to generate output y . Assume ℓ is traded in a frictionless market, where any firm that recruits a worker can get the required unit if it is will to pay the competitive price.⁷

Suppose there is a measure 1 of households and a fixed quantity of land $L < 1$, and at $s = \bar{s}$ steady state unemployment is $\bar{u} < 1 - L$. Then in and around the steady state, demand for ℓ is $1 - u < L$, and so its price is 0. Therefore the effects of small changes in s around \bar{s} are exactly as in the standard model. But consider a big increase in s . As u falls, the demand for ℓ rises until it reaches L , at which point we run out of land, and cannot reduce unemployment further. Any attempt to decrease u bids up the price ρ of ℓ until it exhausts the surplus of the firm, making entry unprofitable. In Figure 2, we cannot lower u much more than what we get at $\bar{s} + \varepsilon$, no matter how big we make s .⁸ This is extreme because we used a Leontieff technology. With a more general CES technology, as u falls demand for ℓ goes up, driving up ρ , and although this may not choke off expansion

⁷It does not matter for our purposes who owns this factor. If it is the workers e.g., their income from selling ℓ does not depend on their employment status and hence does not affect any marginal decision, including their wage bargaining. So general equilibrium effects here have no bearing on u , even if they do affect worker consumption and utility.

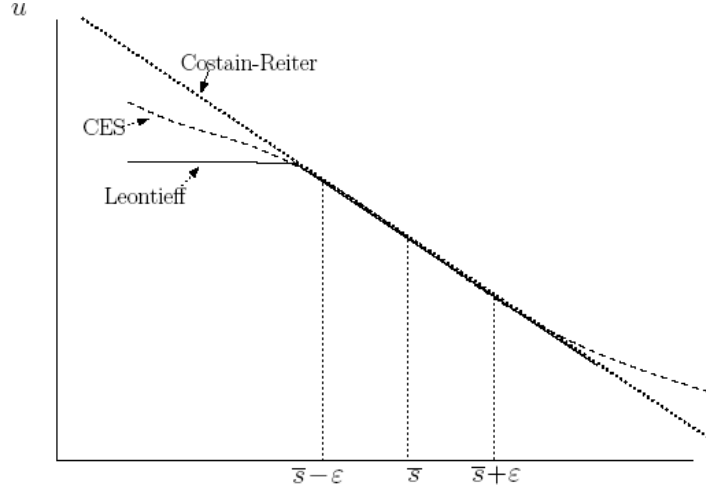
⁸This would not be the case in the long run if we could increase the supply of the factor that is fixed in the short run. For example, if the factor were reproducible capital k , the argument may not be valid across steady states since presumably k can increase with s . But at the business-cycle frequency, when k is nearly fixed, the point is valid. We like using a fixed factor because then we can maintain the useful result that steady state and business cycle effects are the same, which is not the case in models with capital.

altogether it will dampen it. With a more general technology, there is an effect in the other direction, too: as s falls and u increases, the Leontieff case is the same as the standard model since ℓ is free, but if ρ falls this will mitigate the increase in u , as shown in Figure 2.



The general idea also works with a fixed factor in home production, say h , which we call housing for the sake of illustration. Starting again with a Leontieff technology, each unemployed worker needs 1 unit of h in to produce a home good. Assume a fixed stock H such that $u < H$ near steady state, so that h is free. Now consider a fall in s . As long as this fall is not too big, h remains free, and u rises exactly as in the standard model. Once u hits H , however, the number of workers who would like to have a unit of h exceeds the available supply, and the price ω gets bid up to extract the entire surplus from home production. An argument parallel to the case for a fixed factor in market production can be used to show that at least over some range u will not increase at all above H when s falls. And again, if we relax the Leontieff technology in favor of CES, we get a smoothed version

of the same effect that works in both directions. See Figure 3.



The bottom line is that extrapolating the predictions of the model for small changes in s might not work for big changes. In the Leontieff example, with a fixed factor in market production the decrease in u implied by the standard model is correct only up to some point after which u falls no further, and with a fixed factor in home production the increase in u implied by the standard model is correct only up to some point after which u rises no further. With less extreme technologies, the effects are smoothed out, but the basic idea remains valid. The Costain-Reiter critique of Hagedorn-Manovskii based on simple extrapolation therefore simply may not be valid. The model may be accurate for small changes in s , which means it is good for the business cycle, but not for the big changes in s like those across countries.⁹

⁹It is no help trying to argue that one can use econometric estimates of the elasticity (of u with respect to policy) that ought to be equally valid for small and big changes – the whole point here is that the elasticity is *not* constant, and may well differ a lot for small and big changes.

3 A Simple Model

It is standard to reduce the Mortensen-Pissarides model to a *free entry* condition,

$$k = \frac{\lambda_f \eta (y - z)}{r + \delta + (1 - \eta) \lambda_h},$$

where k is the cost of posting a vacancy, λ_f is the arrival rate for a firm with a vacancy, λ_h is the arrival rate for an unemployed worker, η is the bargaining power of the firm, r is the rate of time preference and δ is the job destruction rate, taken for simplicity to be exogenous. This sets the cost of recruiting k equal to the probability of hiring λ_f times the firm's share η of the surplus $y - z$, appropriately discounted. The term $(1 - \eta) \lambda_h$ in the denominator captures feedback from the arrival rate of workers on wage bargaining. The arrival rates come from a standard CRS matching function $\mathcal{N}(u, v)$, with $\lambda_f = \mathcal{N}(u, v)/v$ and $\lambda_h = \mathcal{N}(u, v)/u$. Inserting these as well as the solution $v = v(u)$ to steady state relation $\mathcal{N}(u, v) = \delta(1 - u)$, the above condition reduces to one equation in u .

This is the standard model. Suppose we extend it by writing the value of market and home production as

$$\begin{aligned} y &= \max \{f(\ell) - \rho \ell\} \\ z &= b + \max \{g(h) - \omega h\}, \end{aligned}$$

where as in the previous section $f(\ell)$ is the output of a firm with 1 worker and ℓ units of some additional factor and ρ is the price of ℓ , while $g(h)$ is the home-produced output of an unmatched worker as a function of h and ω is the price of h . Here b is UI plus the value of leisure. Assume $f(\ell) = A\ell^\alpha$ and $g(h) = Bh^\eta$, which are derived from the obvious CRS Cobb-Douglas technologies. We include A and B to capture shocks to market and home productivity.

Individual factor demands for a matched firm and for an unmatched worker are $\ell^D = (\alpha A/\rho)^{\frac{1}{1-\alpha}}$ and $h^D = (\eta B/\omega)^{\frac{1}{1-\omega}}$. Aggregate factor demands are therefore

$$L^D = (1-u) \left(\frac{\alpha A}{\rho} \right)^{\frac{1}{1-\alpha}} \text{ and } H^D = u \left(\frac{\eta B}{\omega} \right)^{\frac{1}{1-\omega}}.$$

Assume supplies of these factors are fixed, and normalized to 1 without loss in generality. Then equilibrium factor prices are $\rho = \alpha A(1-u)^{1-\alpha}$ and $\omega = \eta B u^{1-\omega}$. Since market clearing implies $1 = (1-u)\ell$ and $1 = uh$, in equilibrium, we have:

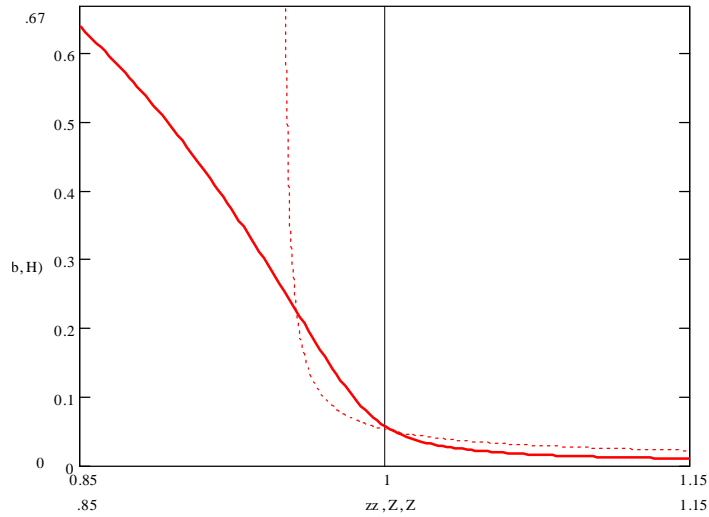
$$\begin{aligned} y &= \frac{A(1-\alpha)}{(1-u)^\alpha} \\ z &= b + \frac{B(1-\eta)}{u^\eta} \end{aligned}$$

Inserting these into free entry, we get

$$k = \frac{\lambda_f \eta}{r + \delta + (1-\eta)\lambda_h} \left[\frac{A(1-\alpha)}{(1-u)^\alpha} - b - \frac{B(1-\eta)}{u^\eta} \right].$$

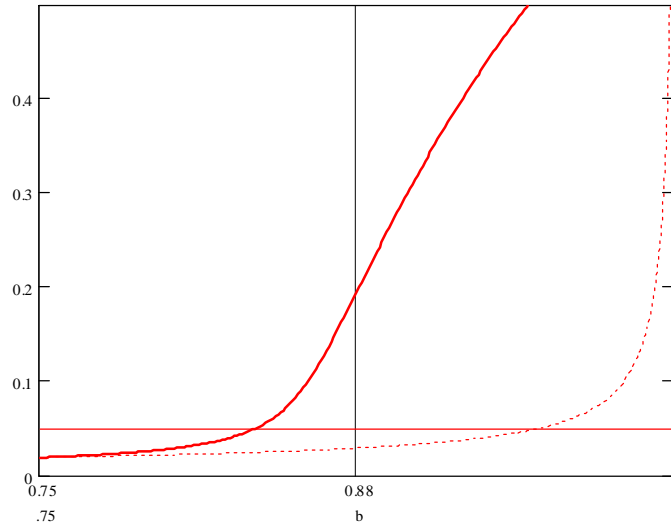
In the standard model, an increase in market productivity A leads firms to post vacancies, but this is dampened by the fact that more vacancies reduce λ_f , and also increase λ_h which increases the wage w . In this model there are other effects, as discussed in the previous section, because more vacancies reduce u which raises the price of ℓ and lowers the price of h as more matched firms and fewer unmatched workers compete for the necessary scarce factors. This further dampens the increase in vacancy creation, but in general it may happen in complicated ways. We saw in the previous section that the factor price effects can be small – actually, zero in the Leontieff case – for small changes in and yet very important for big changes. Hence, small shocks might lead to fluctuations in u that work as if $y-z$ was approximately independent of u , as in the standard model, while big changes are dampened by the factor price effects.

Figure 4 shows, for a numerical example, unemployment vs. productivity in our model with fixed factors as the solid curve and in the standard model as the dotted curve. Both models have the same steady state $u \approx 0.05$. In this example, our model generates even higher response to productivity shocks than the standard model when those shocks are small. But as productivity falls, u does not rise nearly as much. Indeed, in the standard model with y and b independent of u , as y approaches b the market shuts down and u goes to 1. In the model with fixed factors, however, as productivity drops u increases, but it cannot go too high because then the price $\rho = \alpha A(1 - u)^{1-\alpha}$ would go to 0, which means $y = A(1 - \alpha)(1 - u)^{-\alpha}$ would go to ∞ in this Cobb-Douglas case. As can be seen, the increase in u is moderate even when productivity falls a lot. By moderate we do not mean realistic, since the model was not calibrated to match the effect of big changes, we mean the effects are much small than in the standard model.



Another way to look at the same phenomena can be seen in Figure 5. The solid curve gives the steady state unemployment rate as a function of

b for the fixed factor model, while the dotted curve does the same for the standard model. The horizontal line denotes an unemployment rate of 5%, and from the intersection of this line with each curve, one can read off the value of b needed to get the right long-run unemployment rate. A value of b – which we recall captures UI plus leisure – of around 0.83 works in our model, while a value closer to 0.95 is needed in the standard model. An increase in b of a given percentage – say, 5%, which one can think of coming from a 10% increase in UI – leads to a reasonable increase in unemployment in our model, while in the standard model it drives u up to nearly 1.



The examples we present are specific but the point is general. One can get similar results e.g. by introducing home production in other ways – all we require is dependence of the surplus s on unemployment. Thus, u may affect s because the value of home output (rather than the cost of inputs) depends on the number of individuals in nonmarket activity. Consider a domestic service, like a nanny. Assume demand for nannies is independent

of u (this is easy to generalize), while the supply is exactly u . Concretely, an unemployed worker can provide nanny services at competitive price p according to a technology $g(e)$, where e is labor input or effort. Then $z = b + pg(e) - e$, assuming utility is linear in effort. Maximizing with respect to e and equating supply to demand, we get something very similar to the formulation with fixed factors.

4 Conclusion

We considered here the debate over aggregate labor market fluctuations in search models from a new perspective, by in some sense looking at the issues from an older point of view going back to earlier business cycle theory. The bottom line is that the resolution of Shimer's puzzle due to Hagedorn and Manovskii may or may not be definitive, but one cannot base one's conclusion about this on the critique due to Costain and Reiter. The reason is that the elasticities relevant for small changes may not be relevant for large changes. We show explicitly that for simple extensions of the model with slightly more elaborate descriptions of either market or home production, we can generate large effects from small changes as in Hagedorn and Manovskii, and still more reasonable effects from large changes like those that concern Costain and Reiter. We repeat that we find it interesting – almost charming – that home production may be as relevant for the current discussion as it was for earlier business cycle theory, as argued in Benhabib, Rogerson and Wright (1991).

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